Introduction

- Transfer molding technology can be adopted to mold epoxy molding compound (EMC) over Electronic Control Units (ECUs) to endure harsh operating environmental conditions and reduced the manufacturing cost significantly. Yet the presence of a large amount of outer EMC increased the stresses of ECUs during transfer molding process and operations. The long-term reliability assessment should be conducted to make the technology a more viable alternative to various ECUs.

- Piezoresistive stress sensors have been employed to measure the in-situ stress level inside the packages. But, it only measures the local stress level. In order to understand the stress inside the package, it is necessary to develop an accurate numerical modeling which can link stress sensor data to internal structures of interest for failure prognostics.

Objective

- Develop an accurate numerical model developed for failure prognostic of automotive ECU using moiré interferometry for model verification.

Method

- Specimen preparation
  Specimens were grinded to expose the critical components. Specimen gratings were replicated on the cross section for displacement measurement using moiré interferometry.

- Stress data from the stress sensor 
  Reliability analysis of the internal structure

  Verification by Moiré interferometry

  Numerical simulation

  Calibration of Numerical Model Developed for Failure Prognostic of Automotive ECU Using Moiré Interferometry

  Fig. 1 Use stress sensor data for reliability analysis

  Fig. 2 Flow chart for developing the accurate FE model for failure prognostic and health management of ECU

- Set A
  - DPAK Stress sensor
  - PCB

- Set B
  - DPAK Stress sensor
  - Outer EMC

- Convection oven
- specimen
- Computer
- Camera
- PEMI
- Liquid N2 tank
- Power supply

Objective

- Specimen preparation
  Specimens were grinded to expose the critical components. Specimen gratings were replicated on the cross section for displacement measurement using moiré interferometry.

- Experimental results
  - Piezoresistive stress sensors have been employed to measure the in-situ stress level inside the packages. But, it only measures the local stress level. In order to understand the stress inside the package, it is necessary to develop an accurate numerical modeling which can link stress sensor data to internal structures of interest for failure prognostics.

- Numerical model verification
  The numerical results deviated from experimental results which means the initial materials are not 100% correct, which need to be calibrated. A supplementary sensitivity study indicates that the CTE has the highest sensitivity to the displacement fields.

- Impact
  Moiré interferometry is a powerful optical tool for model verification. A numerical model was developed and verified which can be further used for prognostic and health management for ECU coupling with stress sensor.

Related Publication

- B. Wu, et al, “Thermal deformation analysis of automotive electronic control units subjected to passive and active thermal conditions.” 2015 16th EuroSimE.